



Fiber Optic/Cone Penetrometer System for Subsurface Heavy Metals Detection

Technology Need:

The characterization of contaminated soils for heavy metals can be expensive and time consuming due to soil sampling procedures, the high number of samples required to effectively evaluate a site, and the utilization of laboratory chemical analysis techniques. The present laboratory methods of evaluating environmental samples offer high sensitivity and the ability to evaluate multiple chemicals, but the time and cost associated with such methods often limit their effectiveness. The need exists for an economically feasible, real-time, in situ system for the mapping of heavy metal contaminated soils.

Technology Description:

Science and Engineering Associates, Inc. (SEA) has developed an integrated fiber optic sensor/cone penetrometer system to analyze the heavy-metals content of the subsurface. This site characterization tool used the penetrometer to deploy an optical fiber chemical sensor which is based on laser induced breakdown spectroscopy (LIBS).

In LIBS, a pulse from a high-energy laser, typically a Nd:YAG (Neodymium: Yttrium Aluminum Garnet) laser operating at 1.06 μm , is delivered to the soil sample via an optical fiber. The soil sample will absorb the laser pulse, heat rapidly, reduce to elemental form, and become electronically excited. When the input pulse is removed, the excited electrons drop to lower energy levels with the emission of characteristic photons. The plasma emission is returned from the sample via a second fiber to a spectrometer.

Elemental analysis is conducted by observation of the wavelength and intensities of the emission lines, which will depend upon the type and amount of material present within the plasma. This technique has shown to be an effective method for the quantitative analysis of contaminants in soils.

Benefits:

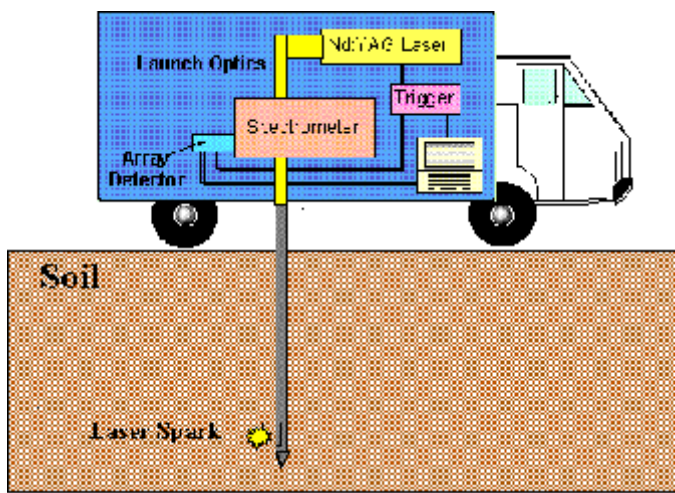
<Cone penetrometer (CPT) deployment of the sensor will enable high-resolution mapping of the subsurface at selected depth increments

<Real-time, in situ analysis will allow for on-site identification of the location of heavy-metal contamination, thus streamlining the remediation process and reducing costs

<Low cost, high production rate

<In situ analysis creates minimal intrusion, and minimal waste generation and minimizes worker exposure to potentially hazardous samples

<Rapid analysis: a single position can be analyzed in less than a minute



Subsurface Heavy Metal Detection System

Status and Accomplishments:

The development of this integrated system took place in a contract with a Base Phase and an Option. The Base effort consisted of the design, construction, and evaluation of fiber optic probe(s) and simulated penetrometer configurations to prove the feasibility of the LIBS system for the analysis of soil samples. Probes developed under the Base effort were evaluated for their ability to conduct quantitative analysis of chromium (Cr) and lead (Pb).

In the Option contract, SEA fabricated a rugged field system which integrated the optical source and detection equipment, optical fiber probes, and cone penetrometer. During this Option, SEA conducted laboratory evaluation and optimization in preparation for field demonstration of the entire system using a cone penetrometer vehicle.

The CPT/LIBS System was successfully demonstrated at the Chemical Waste Landfill (CWL) at Sandia National Laboratory (SNL) outside of Albuquerque, New Mexico. The demonstration focused on measurement of Cr as a function of depth. The CPT/LIBS results correlated well with data collected from past soil borings installed in the test location.



LIBS Backpack Instrument

SEA also successfully field-tested (deployed) two stand-alone LIBS instruments developed by Los Alamos National Laboratory (LANL): a backpack-mounted system for in situ analysis of surficial soils and a van-housed system for field analysis of ex situ soil samples. This field test was conducted at a Formerly Utilized Sites Remedial Action Program (FUSRAP) site in Luckey, Ohio to evaluate the beryllium concentration in surficial soils.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 319
<http://ost.em.doe.gov/tms>

The National Energy Technology Laboratory Internet address is <http://www.netl.doe.gov>

An Innovative Technology Summary Report (ITSR) for this technology can be viewed at <http://apps.em.doe.gov/ost/pubs/itsrs/itsr319.pdf>

For additional information, please visit SEA's website at www.seabase.com